AN ANALYSIS OF THE AQUATIC INVERTEBRATES AND HABITAT OF FOUR STREAMS IN THE TETON RIVER WATERSHED

May 2001

A report to

The Montana Department of Environmental Quality
Helena, Montana

by

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October, 2001

INTRODUCTION

Aquatic invertebrates are aptly applied to bioassessment since they are known to be important indicators of stream ecosystem health (Hynes 1970). Long lives, complex life cycles and limited mobility mean that there is ample time for the benthic community to respond to cumulative effects of environmental perturbations.

This report summarizes data collected in late May 2001 from sites on four streams in the Teton River watershed, Teton County, Montana. Aquatic invertebrate assemblages were sampled by personnel of the Montana Department of Environmental Quality (DEQ) at two sites on Willow Creek (tributary of Deep Creek), at one site on Deep Creek (tributary of the Teton River), at two sites on Spring Creek (tributary of the Teton River), and a single site on Blackleaf Creek (tributary of the North Fork of Muddy Creek). Study sites lie within the Montana Valleys and Foothill Prairies ecoregion (Woods et al. 1999). A multimetric approach to bioassessment such as the one applied in this study uses attributes of the assemblage in an integrated way to measure biotic health. A stream with good biotic health is " ...a balanced, integrated, adaptive system having the full range of elements and processes that are expected in the region's natural environment..." (Karr and Chu 1999). The approach designed by Plafkin et al. (1989) and adapted for use in the State of Montana has been defined as "... an array of measures or metrics that individually provide information on diverse biological attributes, and when integrated, provide an overall indication of biological condition." (Barbour et al. 1995). Community attributes that can contribute meaningfully to interpretation of benthic data include assemblage structure, sensitivity of community members to stress or pollution, and functional traits. Each metric component contributes an independent measure of the biotic integrity of a stream site; combining the components into a total score reduces variance and increases precision of the assessment (Fore et al. 1995). Effectiveness of the integrated metrics depends on the applicability of the underlying model, which rests on a foundation of three essential elements (Bollman 1998). The first of these is an appropriate stratification or classification of stream sites, typically, by ecoregion. Second, metrics must be selected based upon their ability to accurately express biological condition. Third, an adequate assessment of habitat conditions at each site to be studied is needed to assist in the interpretation of metric outcomes.

Implicit in the multimetric method and its associated habitat assessment is an assumption of correlative relationships between habitat parameters and the biotic metrics, in the absence of water quality impairment. These relationships may vary regionally, requiring an examination of habitat assessment elements and biotic metrics and a test of the presumed relationship between them. Bollman (1998) has recently studied the assemblages of the Montana Valleys and Foothill Prairies ecoregion, and has recommended a battery of metrics specific to that ecoregion, which has been shown to be sensitive to impairment, related to habitat assessment parameters and consistent over replicated samples.

Habitat assessment enhances the interpretation of biological data (Barbour and Stribling 1991), because there is generally a direct response of the biological community to habitat degradation in the absence of water quality impairment. If biotic health appears more damaged than the habitat quality would predict, water pollution by metals, other toxicants, high water temperatures, or high levels of organic and/or nutrient pollution might be suspected. On the other hand, an "artificial" elevation of biotic condition in the

presence of habitat degradation may be due to the paradoxical effect of mild nutrient or organic enrichment in an oligotrophic setting.

METHODS

Aquatic invertebrates were sampled by Montana DEQ personnel on May 29, 30, and 31 2001. Six sites on four streams were sampled. Sites are described, and sampling dates indicated in Table 1. The sampling method employed was that recommended in the Montana Department of Environmental Quality (DEQ) Standard Operating Procedures for Aquatic Macroinvertebrate Sampling (Bukantis 1998). In addition to aquatic invertebrate sample collection, habitat quality was visually evaluated at each site and reported by means of the habitat assessment protocols recommended by Bukantis (1998).

Table 1. Sampling sites. Six sites on four streams in the Teton River watershed. May 2001.

Site designation	Waterbody	GPS Location Lat.	GPS Location Long.	Location description
W-up	Willow Creek	47° 48'29" N	112° 28'32"W	headwaters
W-down	Willow Creek	47° 44'20" N	112° 16'58"W	mouth
Deep	Deep Creek	47° 44'26" N	112° 16'37"W	
S-up	Spring Creek	47° 48'47" N	112° 30'48"W	near Choteau
S-down	Spring Creek	47° 47'38" N	112° 08'46"W	mouth
BL	Blackleaf Creek	48° 01'13" N	112° 40'36"W	

Evaluated habitat features include instream conditions, larger-scale channel conditions including flow status, streambank condition, and extent of the riparian zone. Scores were assigned in the field to each habitat measure, and these scores were totaled and compared to the maximum possible score to give an overall assessment of habitat.

Aquatic invertebrate samples and associated habitat data were delivered to Rhithron Biological Associates, Missoula, Montana, for laboratory and data analyses. In the laboratory, the Montana DEQ-recommended sorting method was used to obtain subsamples of at least 300 organisms from each sample, when possible. Organisms were identified to the lowest possible taxonomic levels consistent with Montana DEQ protocols.

To assess aquatic invertebrate communities in this study, a multimetric index developed in previous work for streams of western Montana ecoregions (Bollman 1998) was used. Multimetric indices result in a single numeric score, which integrates the values of several individual indicators of biologic health. Each metric used in this index was tested for its response or sensitivity to varying degrees of human influence.

Correlations have been demonstrated between the metrics and various symptoms of human-caused impairment as expressed in water quality parameters or instream, streambank and stream reach morphologic features. Metrics were screened to minimize variability over natural environmental gradients, such as site elevation or sampling season, which might confound interpretation of results (Bollman 1998). The multimetric index used in this report incorporates multiple attributes of the sampled assemblage into an integrated score that accurately describes the benthic community of each site in terms of its biologic integrity. In addition to the metrics comprising the index, other metrics, which have been shown to be applicable to biomonitoring in other regions (Kleindl 1995, Patterson 1996, Rossano 1995) were used for descriptive interpretation of results. These metrics include the number of "clinger" taxa, long-lived taxa richness, the percent of predatory organisms, and others. They are not included in the integrated bioassessment score, however, since their performance in western Montana ecoregions is unknown. However, the relationship of these metrics to habitat conditions is intuitive and reasonable.

The six metrics comprising the bioassessment index used in this study were selected because both individually and as an integrated metric battery, they are robust at distinguishing impaired sites from relatively unimpaired sites (Bollman 1998). In addition, they are relevant to the kinds of impacts that are present in the Teton River drainage. They have been demonstrated to be more variable with anthropogenic disturbance than with natural environmental gradients (Bollman 1998). Each of the six metrics developed and tested for western Montana ecoregions is described below.

1. **Ephemeroptera (mayfly) taxa richness.** The number of mayfly taxa declines as water quality diminishes. Impairments to water quality which have been demonstrated to adversely affect the ability of mayflies to flourish include elevated water temperatures, heavy metal contamination, increased turbidity, low or high pH, elevated specific conductance and toxic chemicals. Few mayfly species are able to tolerate certain disturbances to instream habitat, such as excessive sediment deposition.
2. **Plecoptera (stonefly) taxa richness.** Stoneflies are particularly susceptible to impairments that affect a stream on a reach-level scale, such as loss of riparian canopy, streambank instability, channelization, and alteration of morphological features such as pool frequency and function, riffle development and sinuosity. Just as all benthic organisms, they are also susceptible to smaller scale habitat loss, such as by sediment deposition, loss of interstitial spaces between substrate particles, or unstable substrate.
3. **Trichoptera (caddisfly) taxa richness.** Caddisfly taxa richness has been shown to decline when sediment deposition affects their habitat. In addition, the presence of certain case-building caddisflies can indicate good retention of woody debris and lack of scouring flow conditions.
4. **Number of sensitive taxa.** Sensitive taxa are generally the first to disappear as anthropogenic disturbances increase. The list of sensitive taxa used here includes organisms sensitive to a wide range of disturbances, including warmer water temperatures, organic or nutrient pollution, toxic pollution, sediment deposition,

substrate instability and others. Unimpaired streams of western Montana typically support at least four sensitive taxa (Bollman 1998).

5. Percent filter feeders. Filter-feeding organisms are a diverse group; they capture small particles of organic matter, or organically enriched sediment material, from the water column by means of a variety of adaptations, such as silken nets or hairy appendages. In forested montane streams, filterers are expected to occur in insignificant numbers. Their abundance increases when canopy cover is lost and when water temperatures increase and the accompanying growth of filamentous algae occurs. Some filtering organisms, specifically the Arctopsychid caddisflies (*Arctopsyche* spp. and *Parapsyche* sp.) build silken nets with large mesh sizes that capture small organisms such as chironomids and early-instar mayflies. Here they are considered predators, and, in this study, their abundance does not contribute to the percent filter feeders metric.

6. Percent tolerant taxa. Tolerant taxa are ubiquitous in stream sites, but when disturbance increases, their abundance increases proportionately. The list of taxa used here includes organisms tolerant of a wide range of disturbances, including warmer water temperatures, organic or nutrient pollution, toxic pollution, sediment deposition, substrate instability and others.

Scoring criteria for each of the six metrics are presented in Table 2. Metrics differ in their possible value ranges as well as in the direction the values move as biological conditions change. For example, Ephemeroptera richness values may range from zero to ten taxa or higher. Larger values generally indicate favorable biotic conditions. On the other hand, the percent filterers metric may range from 0% to 100%; in this case, larger values are negative indicators of biotic health. To facilitate scoring, therefore, metric values were transformed into a single scale. The range of each metric has been divided into four parts and assigned a point score between zero and three. A score of three indicates a metric value similar to one characteristic of a non-impaired condition. A score of zero indicates strong deviation from non-impaired condition and suggests severe degradation of biotic health. Scores for each metric were summed to give an overall score, the total bioassessment score, for each site in each sampling event. These scores were expressed as the percent of the maximum possible score, which is 18 for this metric battery.

Table 2. Metrics and scoring criteria for bioassessment of streams of the Montana Valleys and Foothill Prairies ecoregion (Bollman 1998).

	score			
metric	**3**	**2**	**1**	**0**
Ephemeroptera taxa richness	> 5	5 - 4	3 - 2	< 2
Plecoptera taxa richness	> 3	3 - 2	1	0
Trichoptera taxa richness	> 4	4 - 3	2	< 2
Sensitive taxa richness	> 3	3 - 2	1	0
Percent filterers	0 – 5	5.01 - 10	10.01 - 25	> 25
Percent tolerant taxa	0 – 5	5.01 - 10	10.01 - 35	> 35

The total bioassessment score for each site was expressed in terms of use-support. Criteria for use-support designations were developed by Montana DEQ and are presented in Table 3a. Scores were also translated into impairment classifications according to criteria outlined in Table 3a.

In this report, certain other metrics were used as descriptors of the benthic community response to habitat or water quality but were not incorporated into the bioassessment metric battery, either because they have not yet been tested for reliability in streams of western Montana, or because results of such testing did not show them to be robust at distinguishing impairment, or because they did not meet other requirements for inclusion in the metric battery. These metrics and their use in predicting the causes of impairment or in describing its effects on the biotic community are described below.

- The modified biotic index. This metric is an adaptation of the Hilsenhoff Biotic Index (HBI, Hilsenhoff 1987), which was originally designed to indicate organic enrichment of waters. Values of this metric are lowest in least impacted conditions. Taxa tolerant to saprobic conditions are also generally tolerant of warm water, fine sediment and heavy filamentous algae growth (Bollman, unpublished data). Loss of canopy cover is often a contributor to higher biotic index values. The taxa values used in this report are modified to reflect habitat and water quality conditions in Montana (Bukantis 1998). Ordination studies of the benthic fauna of Montana's foothill prairie streams showed that there is a correlation between modified biotic index values and water temperature, substrate embeddedness, and fine sediment (Bollman 1998). In a study of reference streams, the average value of the modified biotic index in least-impaired streams of western Montana was 2.5 (Wisseman 1992).
- Taxa richness. This metric is a simple count of the number of unique taxa present in a sample. Average taxa richness in samples from reference streams in western Montana was 28 (Wisseman 1992). Taxa richness is an expression of biodiversity, and generally decreases with degraded habitat or diminished water quality. However, taxa richness may show a paradoxical increase when mild nutrient enrichment occurs in previously oligotrophic waters, so this metric must be interpreted with caution.
- Percent predators. Aquatic invertebrate predators depend on a reliable source of invertebrate prey, and their abundance provides a measure of the trophic complexity supported by a site. Less disturbed sites have more plentiful habitat niches to support diverse prey species, which in turn support abundant predator species.
- Number of "clinger" taxa. So-called "clinger" taxa have physical adaptations that allow them to cling to smooth substrates in rapidly flowing water. Aquatic invertebrate "clingers" are sensitive to fine sediments that fill interstices between substrate particles and eliminate habitat complexity. Animals that occupy the hyporheic zones are included in this group of taxa. Expected "clinger" taxa richness in unimpaired streams of western Montana is at least 14 (Bollman, unpublished data).
- Number of long-lived taxa. Long-lived or semivoltine taxa require more than a year to completely develop, and their numbers decline when habitat and/or water

quality conditions are unstable. They may completely disappear if channels are dewatered or if there are periodic water temperature elevations or other interruptions to their life cycles. Western Montana streams with stable habitat conditions are expected to support six or more long-lived taxa (Bollman, unpublished data).

Table 3a. Criteria for the assignment of use-support classifications / standards violation thresholds (Bukantis, 1997)

% Comparability to reference	Use support
>75	Full support--standards not violated
25-75	Partial support--moderate impairment--standards violated
<25	Non-support--severe impairment--standards violated

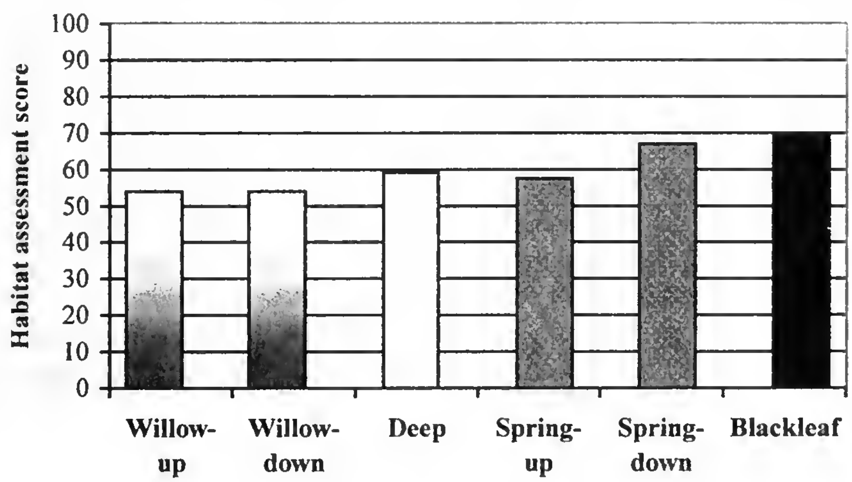
Table 3b. Criteria for the assignment of impairment classifications (Plafkin et al. 1989)

% Comparability to reference	Classification
> 83	nonimpaired
54-79	slightly impaired
21-50	moderately impaired
<17	severely impaired

RESULTS

Habitat assessment

Figure 1 compares habitat assessment results for the twelve sites in this study. Table 4 itemizes the evaluated habitat parameters and shows the assigned scores for each.



Sites on Deep Creek, Spring Creek, and Blackleaf Creek appeared to have sub-optimal overall habitat condition, but at sites on Willow Creek, habitat conditions appeared to be marginal. At the upper site on Willow Creek, fine sediment deposition was noted and large substrate components were reported to be 50-60% embedded with fines. Sand and gravel predominated in riffles. Habitat was also compromised by low flow; the investigator reported small riffles, and some standing pools. Marginal bank stability was perceived as small areas of high erosion, but deep-rooted plants were also present. On one bank, the riparian zone was judged limited in extent. At the lower site on Willow Creek, sand and gravel predominated in the riffles, but embeddedness did not appear to be as severe a problem as at the upper site. Flow conditions were reported to be optimal at the site. Bank stability was judged marginal, with browsed pasture grasses providing most of the vegetative cover. The riparian zone was virtually non-existent; no willows were present, and no other deep-rooted plants were noted.

Instream habitat features at the site on Deep Creek were judged mostly optimal or sub-optimal, with well-developed riffles, diverse substrate, and minimal embeddedness reported. Streambank and riparian conditions were less than ideal, however. Erosion potential of streambanks was perceived to be high, and downcutting was noted, which limited the vegetation present on streambanks. Riparian zone width was also limited.

At the upper site on Spring Creek, benthic substrate was dominated by gravel, though some cobble was present; instream habitat was judged marginal. Substrates were not deeply embedded by fine particles, and the pebble count reportedly indicated few fines. Flow conditions were reported to be optimal. Channel alteration was considerable; this reach of Spring Creek flows through the city of Choteau, and it is channelized throughout much of the reach. Flow status was judged optimal, with no substrate exposed. Streambank and riparian conditions were problematic in this reach; streambank erosion was moderate on one bank, and non-native grasses were the predominant vegetation on both banks. The riparian zone width was minimal. Near the mouth, Spring Creek instream habitat was poor, with monotonous substrate comprised mostly of mud and some embeddedness reported. Here, no channel alteration was noted, and flow conditions were sub-optimal with a moderate amount of substrate exposed in the riffle. Streambank conditions were better here than at the upstream site, although some erosion was noted, and vegetative cover consisted mostly of grasses. The riparian zone width was rated sub-optimal.

Habitat assessment at the site on Blackleaf Creek resulted in the highest score among the sites studied; overall conditions were sub-optimal here. Instream conditions provided good habitat, with diverse substrate particles present, and only a mild degree of embeddedness noted. A road crossing above the sampling site was perceived to be a potential source of sediment deposition, and slight deposition of fines was noted. Flow conditions were sub-optimal, and the field investigator suggested that drought conditions and not irrigation diversion was responsible. Streambanks were unstable on one side of the stream, active erosion was noted, but the opposite bank was perceived to be stable. Vegetative cover of streambanks was noted to be sub-optimal, with bushes and grasses being the predominant plants present.

Max. possible score	Parameter	Sites					
		Willow up	Willow down	Deep	Spring up	Spring down	Blackleaf
10	Riffle development	7	9	9	10	6	9
10	Benthic substrate	3	3	6	4	2	8
20	Embeddedness	8	13	11	19	12	17
20	Channel alteration	17	19	16	3	16	17
20	Sediment deposition	5	11	11	19	10	15
20	Channel flow status	7	16	16	20	13	14
20	Bank stability r / l	9 / 4	5 / 5	3 / 5	9 / 4	8 / 8	3 / 6
20	Bank vegetation r / l	6 / 7	3 / 3	3 / 5	1 / 1	8 / 8	6 / 6
20	Vegetated zone r / l	9 / 4	0 / 0	2 / 7	1 / 1	8 / 8	2 / 9
160	**Total**	**86**	**87**	**94**	**92**	**107**	**112**
	Percent of maximum	**54**	**54**	**59**	**57.5**	**67**	**70**
	CONDITION*	**MARG**	**MARG**	**SUB**	**SUB**	**SUB**	**SUB**

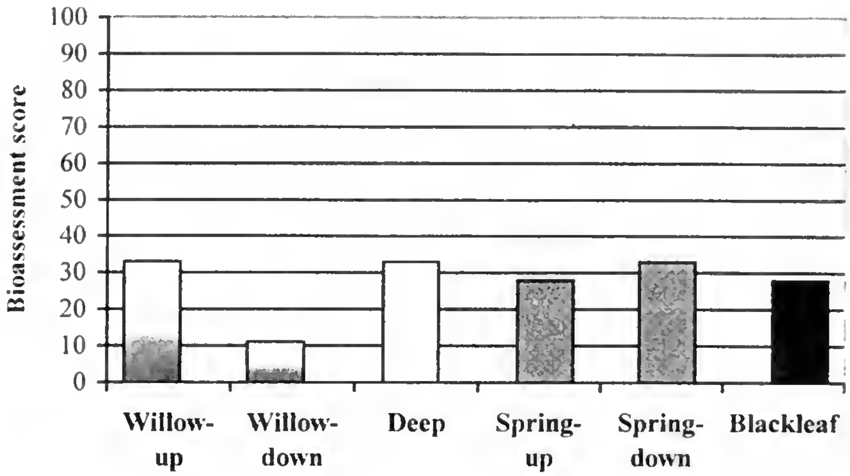
*Condition categories: Optimal (OPT) > 80% of maximum score; Sub-optimal (SUB) 75 - 56%; Marginal (MARG) 49 - 29%; Poor <23%. Adapted from Plafkin et al. 1988.

Table 4. Stream and riparian habitat assessment: four streams of the Teton River watershed. May 2001.

Bioassessment

Invertebrate taxa lists, metric results and other information for each sample are given in the Appendix. Figure 2 compares the total bioassessment scores calculated for invertebrate communities collected at each of the six sites. Breakdown of scores for each metric calculated from the invertebrate samples is presented in Table 5.

Figure 2. Total bioassessment scores, expressed as percent of maximum, for six sites in the Teton River watershed, May 2001.



Bioassessment scores using this method indicated moderate impairment of biotic health and only partial support of designated uses at all sites studied except for the lower site on Willow Creek. Scores at this site indicated non-support of designated uses and severe impairment of biotic health. Generally, sites had fewer Ephemeroptera taxa than expected, and most entirely lacked Plecoptera taxa. Most sites had fewer Trichoptera taxa than expected. Only a single individual of a sensitive taxon was collected in the entire sampling effort. Most sites supported assemblages largely composed of tolerant taxa. And filter feeders were very abundant at three of the six sites. In general, all sites but one produced similar overall bioassessment scores. The assemblage collected at the severely impaired site lower Willow Creek site scored poorly on all metric components. Each of the other sites produced at least one "good" metric score.

Invertebrate communities

High biotic index values (6.65 at the upper site and 6.55 at the lower site) were calculated for benthic assemblages collected at both sites on Willow Creek. In addition, only two mayfly taxa were collected at each site. These findings suggest that water quality degradation could have been a factor limiting the health of the biotic communities in Willow Creek. The source of this degradation may have been organic and/or nutrient pollution, or warm water temperatures, or both. At the lower site, the mayfly taxa present in the sample were the ubiquitous *Baetis tricaudatus*, and another baetid, *Acentrella turbida*. While the presence of these animals does not suggest particularly cold water,

Table 5. Metric values and bioassessments for six sites in theTeton River watershed. May 2001.

	Sites					
	Willow - up	Willow - down	Deep	Spring- up	Spring - down	Blackleaf
Metrics						
Ephemeroptera richness	2	2	4	1	3	1
Plecoptera richness	0	0	0	0	0	1
Trichoptera richness	2	0	5	2	4	1
Sensitive taxa richness	0	0	0	0	0	1
Percent tolerant taxa	27	13	47	16	60	<1
Percent filter-feeders	4	34	24	1	2	61
	Metric scores					
Ephemeroptera richness	1	1	2	0	1	0
Plecoptera richness	0	0	0	0	0	1
Trichoptera richness	1	0	3	1	2	0
Sensitive taxa richness	0	0	0	0	0	1
Percent tolerant taxa	1	1	0	1	0	3
Percent filter-feeders	3	0	1	3	3	0
Total score	6	2	6	5	6	5
Percent of maximum	**33**	**11**	**33**	**28**	**33**	**28**
Use support*	**PART**	**NON**	**PART**	**PART**	**PART**	**PART**
Impairment class	**MOD**	**SEVERE**	**MOD**	**MOD**	**MOD**	**MOD**

[1] Classifications: (NON) non-impaired, (SLI) slightly impaired, (MOD) moderately impaired, (SEVERE) severely impaired. See Table 3b.

*Use support designations: See Table 3a.

they do provide a contrast with the mayflies collected at the upper site, which were *Caenis latipennis* and *Hexagenia* sp. Both of these mayflies are associated with warmer water temperatures. Fine sediments and anoxic substrate conditions are suggested by the midge fauna of the upper site; four taxa collected there are characteristic of those conditions. They include *Cryptotendipes* sp., *Microtendipes* sp., and *Dicrotendipes* sp., all hemoglobin-bearing animals. Anoxic substrate conditions may be associated with warm water temperatures. Only a single specimen of *Dicrotendipes* sp. was present in the sample taken at the lower Willow Creek site. Each of the two sites supported two semivoltine taxa, suggesting that dewatering or other catastrophic events have not recently interrupted long life cycles.

Fine sediments are evidently abundant at both sites. Sediment tolerant taxa were large components of both assemblages; at the upper site the elmid *Dubiraphia* sp., the mayfly *Caenis latipennis*, and the midge *Cricotopus bicinctus* together comprised more than 50% of the assemblage. At the lower site *Cricotopus bicinctus* was the dominant taxon, representing 37% of the animals in the sample. Some clean hard substrate appeared to be present at the lower site, however, since 10 "clinger" taxa were collected there. The upper site supported only 4 "clingers".

The absence of stoneflies at both sites suggests disturbance of habitat on a reach scale, such as channel alteration, extensive streambank instability, and/or loss of riparian function. Shredder taxa were also missing from the functional groups present, suggesting

that riparian inputs of large organic debris were inconsequential, or that hydrologic conditions prevented the retention of such material. The filter-feeding blackfly *Simulium* sp. was very abundant at the lower site, comprising 34% of the assemblage. Abundant filter-feeders suggest that small organic material in suspension was plentiful, however, some biologists dispute the interpretation of the finding of large numbers of this blackfly in a sample. The animal is gregarious, and the collection of a large number of them may occur by chance.

At the Deep Creek site, which was located below the Willow Creek confluence, 4 mayfly taxa and a moderately elevated biotic index score (5.49) suggest that water quality was somewhat better at this site than in Willow Creek. Both the mayfly taxa richness, and the biotic index value, however, still deviate from expectations for a valley or foothill prairie stream. Other evidence for degraded water quality is suggested by the large proportion of tolerant organisms present; 47% of the sampled assemblage was comprised of animals generally insensitive to disturbances in habitat or water quality. These included the caddis flies *Cheumatopsyche* sp., *Oecetis* sp., and *Hydroptila* sp. and the mayfly *Tricorythodes minutus*. No sensitive organisms were collected. Impairment of water quality could be due to organic and/or nutrient pollution or elevated water temperatures. Three long-lived taxa were collected.

Relatively clean substrates are indicated by the presence of 10 "clinger" taxa and 5 caddis fly taxa in the sample collected at this site. Sandy or gravelly conditions also appear to occur at the site, since the midge *Pseudochironomus* sp. was present. As at the Willow Creek sites, stoneflies seem to be absent, suggesting reach-scale disturbance such as riparian zone degradation, downcutting, and/or extensive streambank erosion.

Functionally, there appears to be a balance among grazing taxa, filter-feeders, and scrapers, suggesting that ample organic material exists in this reach, both as suspended fine particles and in solution. Lack of riparian shading is suggested by the abundance of scrapers.

Both sites on Spring Creek exhibited evidence of impaired water quality; low mayfly taxa richness and high calculated biotic index values (6.50 at the upper site, and 6.42 at the lower site) characterized the collected assemblages. Worms and midges dominated the community sampled at the upper site; together these 2 groups comprised 66% of the animals in the sample. These same groups were abundant, though not dominant at the lower site, where 15% of the animals collected were tubificid worms, probably all *Limnodrilus hoffmeisteri*. Water quality impairment could have been attributable to nutrient and/or organic pollution, and/or elevated water temperatures. Again, an adequate representation of long-lived taxa at both sites suggested that surface flow had not been recently interrupted.

The absence of stoneflies suggests reach scale disturbances to habitat similar to the other sites in the study. Instream habitat conditions appear to be somewhat limited by fine sediment, since only 6 "clinger" taxa occurred at either site. There were also fewer caddis fly taxa than expected at both sites. No "clinger" or caddis fly was particularly abundant at the upper site, while the elmid *Optioservus* sp. occurred in large numbers at the lower site, suggesting that fine sediment deposition compromised habitats somewhat more at the upper site than at the lower.

Community function seems to be skewed towards grazing taxa and omnivores at the upper site, and toward grazers and scrapers at the lower site. Large proportions of

generalists such as grazers and omnivores may signal declines in a community's biotic health, as specialist taxa drop out due to habitat or water quality degradation. At the lower site, the abundance of scrapers suggests that riparian shading is lacking at that site.

The sample taken at the Blackleaf Creek site contained few organisms, which resulted in low taxa richness (13) and which makes interpretation of the taxonomic composition and metric performance of the assemblage difficult. It is not clear whether the low abundance of animals in the sample was due to habitat or water quality conditions or was an artifact of sampling. The field investigator reported that the streambed was "hard, potentially bedrock", and this type of instream habitat can produce depauperate invertebrate samples.

The assemblage collected here was dominated by the blackfly *Prosimulium* sp., which comprised 60% of the sampled organisms. As with *Simulium* sp., the collection of large numbers of this animal may be due to chance, however, abundant fine particulate matter in suspension is necessary to support big populations of the animal. The presence of *Prosimulium* sp. also suggests that elevated water temperatures do not impair biotic health at this site, as does the presence of a single specimen of the caddis fly *Rhyacophila tucula*, the only sensitive taxon present in any sample in this study. The biotic index value calculated from this community was low (2.84), suggesting that water quality was not degraded. On the other hand, only a single mayfly taxon was collected; mayfly taxa richness has been shown to be correlated with water quality in valley and foothill streams. However, low abundance of invertebrates in the sample makes these hypotheses tenuous.

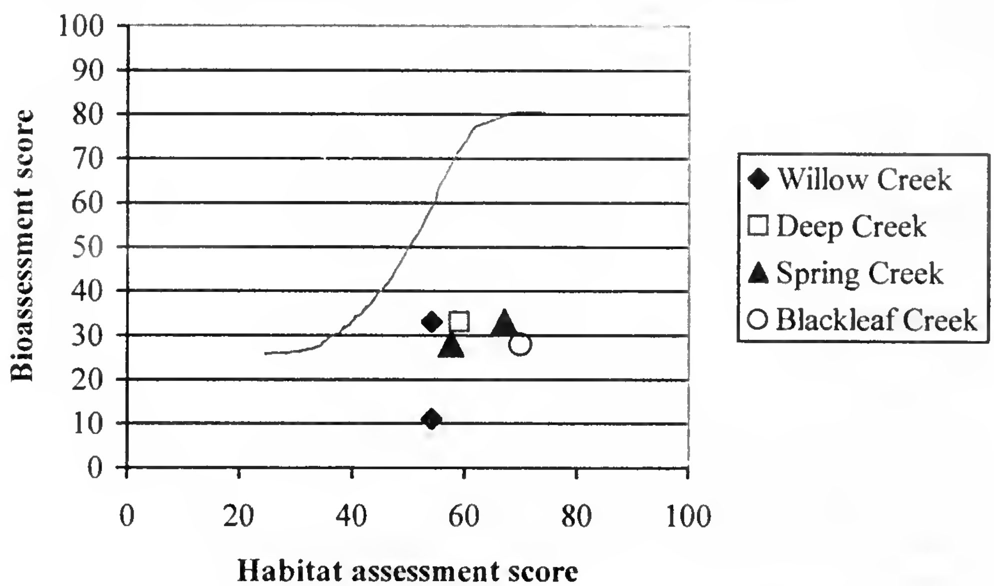
The other abundant organism present at this site was the nemourid Podmosta sp., a shredder. This stonefly comprised 30% of the organisms collected here, and it's abundance suggests that riparian inputs of large organic debris were ample, and that hydrologic conditions likely favored retention of this material.

CONCLUSIONS

- Impaired water quality appeared to limit biotic health at sites on Willow Creek, Deep Creek, and Spring Creek. Impairment may be due to nutrient pollution and/or water temperature elevation.
- Fine sediment deposition, with subsequent loss of instream habitat complexity seemed to add to the loss of biotic integrity at sites on Willow Creek and Spring Creek.
- Abundant filter-feeders at the lower Willow Creek site, the Deep Creek site, and the Blackleaf Creek site suggest that fine organic particles in suspension were plentiful in these reaches.
- Functional generalists have replaced specialists at all sites except Blackleaf Creek, suggesting moderate-to-severe impairment of biotic integrity at these sites.
- Water quality appears to be unimpaired at the Blackleaf Creek site, but instream habitats appear to be limited by hard substrates. However, low abundance of invertebrates in the sample make all hypotheses weak, since it is not clear whether this is due to habitat conditions or sampling error.

- The relationship between habitat assessment scores and bioassessment scores suggests that water quality was a limiting factor to the biotic health of the benthic communities at all sites. Habitat degradation was also present at some sites, primarily in the form of sediment deposition, but impaired water quality appeared to be the more influential factor on the benthic assemblages. Figure 3 illustrates this. Points representing the sites lie below a line describing the expected relationship between habitat and biotic health when water quality is unimpaired. This suggests that bioassessment scores are somewhat lower than would be expected if impairment was due to habitat degradation alone, and suggests that water quality impairment, perhaps by warm water temperatures or nutrient pollution, was the predominant factor limiting biotic health at these sites. Low invertebrate abundance in the sample taken at the Blackleaf Creek site compromises conclusions concerning the site.

Figure 3. Total bioassessment scores plotted against habitat assessment scores for six sites in the Teton River watershed, May 2001. The red line describes the hypothetical relationship expected when water quality is good and biotic health is determined predominantly by habitat quality (Barbour and Stribling 1991).



LITERATURE CITED

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APPENDIX

Taxonomic data and summaries

Six sites in the Teton River watershed

May 2001

Aquatic Invertebrate Taxonomic Data

Site Name: Willow Creek, headwaters
Site ID: 5/30/01

Approx. percent of sample used: 7

Taxon	**Quantity**	**Percent**	**HBI**	**FFG**
Limnodrilus hoffmeisteri	28	9.30	9	CG
Sphaeriidae	3	1.00	8	CG
Ferrissia sp.	3	1.00	6	SC
Acari	15	4.98	5	PA
Total Misc. Taxa	**49**	**16.28**		
Caenis latipennis	18	5.98	7	CG
Hexagenia sp.	1	0.33	6	CG
Heptageniidae - early instar	1	0.33	4	SC
Total Ephemeroptera	**20**	**6.64**		
Hydroptila sp.	20	6.64	6	PH
Polycentropus sp.	1	0.33	6	PR
Total Trichoptera	**21**	**6.98**		
Dubiraphia sp.	26	8.64	6	CG
Optioservus sp.	9	2.99	4	SC
Total Coleoptera	**35**	**11.63**		
Ceratopogoninae	9	2.99	6	PR
Simulium sp.	1	0.33	6	CF
Tabanidae	1	0.33	8	PR
Total Diptera	**11**	**3.65**		
Cladotanytarsus sp.	15	4.98	7	CG
Cricotopus sp.	110	36.54	7	CG
Cryptochironomus sp.	2	0.66	8	PR
Cryptotendipes sp.	1	0.33	6	UN
Dicrotendipes sp.	1	0.33	8	CG
Microtendipes sp.	6	1.99	6	CG
Pagastia sp.	1	0.33	1	CG
Polypedilum sp.	7	2.33	6	OM
Rheotanytarsus sp.	1	0.33	6	CF
Stempellinella sp.	3	1.00	4	UN
Tanytarsus sp.	9	2.99	6	CF
Thienemannimyia Gr.	9	2.99	6	PR
Total Chironomidae	**165**	**54.82**		
Grand Total	**301**	**100.00**		

Aquatic Invertebrate Summary Data

Site Name: Willow Creek, headwaters **Site ID: 5/30/01**

TOTAL ABUNDANCE	301
Ephemeroptera + Plecoptera + Trichoptera (EPT) abundance	41
TOTAL NUMBER OF TAXA	26
Number EPT taxa	5

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Misc. Taxa	4	49	16.28
Odonata	0	0	0.00
Ephemeroptera	3	20	6.64
Plecoptera	0	0	0.00
Hemiptera	0	0	0.00
Megaloptera	0	0	0.00
Trichoptera	2	21	6.98
Lepidoptera	0	0	0.00
Coleoptera	2	35	11.63
Diptera	3	11	3.65
Chironomidae	12	165	54.82

RATIOS OF TAX GROUP ABUNDANCES

EPT/Chironomidae	0.25

FUNCTIONAL FEEDING GROUP (FFG) COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Predator	5	22	7.31
Parasite	1	15	4.98
Collector-gatherer	10	209	69.44
Collector-filterer	3	11	3.65
Macrophyte-herbivore	0	0	0.00
Piercer-herbivore	1	20	6.64
Scraper	3	13	4.32
Shredder	0	0	0.00
Xylophage	0	0	0.00
Omnivore	1	7	2.33
Unknown	2	4	1.33

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filterer	1.18
Scraper/(Scraper + C.filterer)	0.54
Shredder/Total organisms	0.00

CONTRIBUTION OF DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Cricotopus sp.	110	36.54
Limnodrilus hoffmeisteri	28	9.30
Dubiraphia sp.	26	8.64
Hydroptila sp.	20	6.64
Caenis latipennis	18	5.98
SUBTOTAL 5 DOMINANTS	202	67.11
Acari	15	4.98
Cladotanytarsus sp.	15	4.98
Optioservus sp.	9	2.99
Ceratopogoninae	9	2.99
Tanytarsus sp.	9	2.99
TOTAL DOMINANTS	250	83.06

SAPROBIC INDICES

Hilsenhoff Biotic Index	6.65

DIVERSITY MEASURES

Shannon H (loge)	2.37
Shannon H (log2)	3.43
Evenness	0.73
Simpson D	0.16

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	154	51.25
Univoltine	110	36.46
Semivoltine	37	12.29

	#TAXA	ABUNDANCE	PERCENT
Tolerant	9	81	26.91
Intolerant	0	0	0.00
Clinger	10	185	61.46

Aquatic Invertebrate Taxonomic Data

Site Name: Willow Creek above confluence

Site ID: 5/29/01

Approx. percent of sample used: 4

Taxon	Quantity	Percent	HBI	FFG
Naididae	41	12.50	8	CG
Tubificidae - immature	1	0.30	9	CG
Eiseniella tetraedra	2	0.61	8	CG
Physidae	1	0.30	8	CG
Acari	2	0.61	5	PA
Total Misc. Taxa	**47**	**14.33**		
Acentrella turbida	1	0.30	4	CG
Baetis tricaudatus	22	6.71	6	CG
Total Ephemeroptera	**23**	**7.01**		
Optioservus sp.	7	2.13	4	SC
Zaitzevia sp.	1	0.30	4	CG
Total Coleoptera	**8**	**2.44**		
Ceratopogoninae	1	0.30	6	PR
Simulium sp.	111	33.84	6	CF
Total Diptera	**112**	**34.15**		
Cricotopus Bicinctus Gr.	74	22.56	7	CG
Dicrotendipes sp.	1	0.30	8	CG
Eukiefferiella Pseudomontana Gr.	11	3.35	8	OM
Micropsectra sp.	20	6.10	7	CG
Orthocladius sp.	18	5.49	6	CG
Parametriocnemus sp.	5	1.52	5	CG
Thienemannimyia Gr.	4	1.22	6	PR
Tvetenia sp.	5	1.52	5	CG
Total Chironomidae	**138**	**42.07**		
Grand Total	**328**	**100.00**		

Aquatic Invertebrate Summary Data

Site Name: Willow Creek above confluence **Site ID: 5/29/01**

TOTAL ABUNDANCE	328
Ephemeroptera + Plecoptera + Trichoptera (EPT) abundance	23
TOTAL NUMBER OF TAXA	19
Number EPT taxa	2

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Misc. Taxa	5	47	14.33
Odonata	0	0	0.00
Ephemeroptera	2	23	7.01
Plecoptera	0	0	0.00
Hemiptera	0	0	0.00
Megaloptera	0	0	0.00
Trichoptera	0	0	0.00
Lepidoptera	0	0	0.00
Coleoptera	2	8	2.44
Diptera	2	112	34.15
Chironomidae	8	138	42.07

RATIOS OF TAX GROUP ABUNDANCES

EPT/Chironomidae	0.17

FUNCTIONAL FEEDING GROUP (FFG) COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Predator	2	5	1.52
Parasite	1	2	0.61
Collector-gatherer	13	192	58.54
Collector-filterer	1	111	33.84
Macrophyte-herbivore	0	0	0.00
Piercer-herbivore	0	0	0.00
Scraper	1	7	2.13
Shredder	0	0	0.00
Xylophage	0	0	0.00
Omnivore	1	11	3.35
Unknown	0	0	0.00

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filterer	0.06
Scraper/(Scraper + C.filterer)	0.06
Shredder/Total organisms	0.00

CONTRIBUTION OF DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Simulium sp.	111	33.84
Cricotopus Bicinctus Gr.	74	22.56
Naididae	41	12.50
Baetis tricaudatus	22	6.71
Micropsectra sp.	20	6.10
SUBTOTAL 5 DOMINANTS	268	81.71
Orthocladius sp.	18	5.49
Eukiefferiella Pseudomontana (	11	3.35
Optioservus sp.	7	2.13
Parametriocnemus sp.	5	1.52
Tvetenia sp.	5	1.52
TOTAL DOMINANTS	314	95.73

SAPROBIC INDICES

Hilsenhoff Biotic Index	6.55

DIVERSITY MEASURES

Shannon H (loge)	2.02
Shannon H (log2)	2.91
Evenness	0.69
Simpson D	0.19

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	123	37.42
Univoltine	197	60.14
Semivoltine	8	2.44

	#TAXA	ABUNDANCE	PERCENT
Tolerant	6	43	13.11
Intolerant	0	0	0.00
Clinger	4	193	58.84

Aquatic Invertebrate Taxonomic Data

Site Name: Deep Creek below Willow Creek

Site ID: 5/29/01

Approx. percent of sample used: 13

Taxon	Quantity	Percent	HBI	FFG
Limnodrilus hoffmeisteri	8	2.61	9	CG
Sphaeriidae	2	0.65	8	CG
Acari	5	1.63	5	PA
Total Misc. Taxa	**15**	**4.89**		
Baetis tricaudatus	13	4.23	6	CG
Stenonema sp.	9	2.93	5	SC
Paraleptophlebia temporalis	2	0.65	4	CG
Tricorythodes minutus	10	3.26	4	CG
Total Ephemeroptera	**34**	**11.07**		
Brachycentrus sp.-early instar	1	0.33	1	OM
Cheumatopsyche sp.	22	7.17	8	CF
Hydropsyche sp.	49	15.96	4	CF
Hydroptila sp.	1	0.33	6	PH
Oecetis sp.	6	1.95	8	OM
Total Trichoptera	**79**	**25.73**		
Optioservus sp.	57	18.57	4	SC
Zaitzevia sp.	10	3.26	4	CG
Total Coleoptera	**67**	**21.82**		
Ceratopogoninae	13	4.23	6	PR
Simulium sp.	4	1.30	6	CF
Total Diptera	**17**	**5.54**		
Brillia sp.	1	0.33	5	SH
Cladotanytarsus sp.	3	0.98	7	CG
Cricotopus Trifascia Gr.	7	2.28	6	CG
Diamesa sp.	1	0.33	5	CG
Eukiefferiella Pseudomontana Gr.	16	5.21	8	OM
Micropsectra sp.	2	0.65	7	CG
Microtendipes sp.	2	0.65	6	CG
Orthocladius sp.	55	17.92	6	CG
Polypedilum sp.	3	0.98	6	OM
Pseudochironomus sp.	2	0.65	5	CG
Thienemanniella sp.	1	0.33	6	CG
Thienemannimyia Gr.	2	0.65	6	PR
Total Chironomidae	**95**	**30.94**		
Grand Total	**307**	**100.00**		

Aquatic Invertebrate Summary Data

Site Name: Deep Creek below Willow Creek **Site ID: 5/29/01**

TOTAL ABUNDANCE	307
Ephemeroptera + Plecoptera + Trichoptera (EPT) abundance	113
TOTAL NUMBER OF TAXA	28
Number EPT taxa	9

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Misc. Taxa	3	15	4.89
Odonata	0	0	0.00
Ephemeroptera	4	34	11.07
Plecoptera	0	0	0.00
Hemiptera	0	0	0.00
Megaloptera	0	0	0.00
Trichoptera	5	79	25.73
Lepidoptera	0	0	0.00
Coleoptera	2	67	21.82
Diptera	2	17	5.54
Chironomidae	12	95	30.94

RATIOS OF TAX GROUP ABUNDANCES

EPT/Chironomidae	1.19

FUNCTIONAL FEEDING GROUP (FFG) COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Predator	2	15	4.89
Parasite	1	5	1.63
Collector-gatherer	14	118	38.44
Collector-filterer	3	75	24.43
Macrophyte-herbivore	0	0	0.00
Piercer-herbivore	1	1	0.33
Scraper	2	66	21.50
Shredder	1	1	0.33
Xylophage	0	0	0.00
Omnivore	4	26	8.47
Unknown	0	0	0.00

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filterer	0.88
Scraper/(Scraper + C.filterer)	0.47
Shredder/Total organisms	0.00

CONTRIBUTION OF DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Optioservus sp.	57	18.57
Orthocladius sp.	55	17.92
Hydropsyche sp	49	15.96
Cheumatopsyche sp.	22	7.17
Eukiefferiella Pseudomontana (	16	5.21
SUBTOTAL 5 DOMINANTS	199	64.82
Baetis tricaudatus	13	4.23
Ceratopogoninae	13	4.23
Tricorythodes minutus	10	3.26
Zaitzevia sp.	10	3.26
Stenonema sp.	9	2.93
TOTAL DOMINANTS	245	79.80

SAPROBIC INDICES

Hilsenhoff Biotic Index	5.49

DIVERSITY MEASURES

Shannon H (loge)	2.61
Shannon H (log2)	3.77
Evenness	0.78
Simpson D	0.11

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	105	34.04
Univoltine	134	43.49
Semivoltine	69	22.48

	#TAXA	ABUNDANCE	PERCENT
Tolerant	9	144	46.91
Intolerant	0	0	0.00
Clinger	10	163	53.09

Aquatic Invertebrate Taxonomic Data

Site Name: Spring Creek, Choteau Park

Site ID: 5/31/01

Approx. percent of sample used: 100

Taxon	Quantity	Percent	HBI	FFG
Enchytraeidae	1	0.70	4	CG
Eiseniella tetraedra	44	30.77	8	CG
Sphaeriidae	7	4.90	8	CG
Fossaria sp.	2	1.40	6	CG
Physidae	1	0.70	8	CG
Gyraulus sp.	2	1.40	8	SC
Total Misc. Taxa	**57**	**39.86**		
Caenis latipennis	1	0.70	7	CG
Total Ephemeroptera	**1**	**0.70**		
Sigara sp.	2	1.40	8	PH
Total Hemiptera	**2**	**1.40**		
Hydroptila sp.	3	2.10	6	PH
Lepidostoma sp.-turret case larvae	7	4.90	2	SH
Total Trichoptera	**10**	**6.99**		
Dytiscidae - larvae	7	4.90	5	PR
Dubiraphia sp.	1	0.70	6	CG
Optioservus sp.	6	4.20	4	SC
Total Coleoptera	**14**	**9.79**		
Ceratopogoninae	1	0.70	6	PR
Chelifera sp.	1	0.70	6	PR
Simulium sp.	1	0.70	6	CF
Tipula sp.	7	4.90	4	OM
Total Diptera	**10**	**6.99**		
Eukiefferiella Devonica Gr.	1	0.70	4	OM
Micropsectra sp.	24	16.78	7	CG
Orthocladius sp.	3	2.10	6	CG
Polypedilum sp.	16	11.19	6	OM
Tanytarsus sp.	1	0.70	6	CF
Thienemannimyia Gr.	3	2.10	6	PR
Tribelos sp.	1	0.70	6	UN
Total Chironomidae	**49**	**34.27**		
Grand Total	**143**	**100.00**		

Aquatic Invertebrate Summary Data

Site Name: Spring Creek, Choteau Park **Site ID: 5/31/01**

TOTAL ABUNDANCE	143
Ephemeroptera + Plecoptera + Trichoptera (EPT) abundance	11
TOTAL NUMBER OF TAXA	24
Number EPT taxa	3

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Misc. Taxa	6	57	39.86
Odonata	0	0	0.00
Ephemeroptera	1	1	0.70
Plecoptera	0	0	0.00
Hemiptera	1	2	1.40
Megaloptera	0	0	0.00
Trichoptera	2	10	6.99
Lepidoptera	0	0	0.00
Coleoptera	3	14	9.79
Diptera	4	10	6.99
Chironomidae	7	49	34.27

RATIOS OF TAX GROUP ABUNDANCES

EPT/Chironomidae	0.22

FUNCTIONAL FEEDING GROUP (FFG) COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Predator	4	12	8.39
Parasite	0	0	0.00
Collector-gatherer	9	84	58.74
Collector-filterer	2	2	1.40
Macrophyte-herbivore	0	0	0.00
Piercer-herbivore	2	5	3.50
Scraper	2	8	5.59
Shredder	1	7	4.90
Xylophage	0	0	0.00
Omnivore	3	24	16.78
Unknown	1	1	0.70

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filterer	4.00
Scraper/(Scraper + C.filterer)	0.80
Shredder/Total organisms	0.03

CONTRIBUTION OF DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Eiseniella tetraedra	44	30.77
Micropsectra sp.	24	16.78
Polypedilum sp.	16	11.19
Sphaeriidae	7	4.90
Lepidostoma sp.-turret case lar	7	4.90
SUBTOTAL 5 DOMINANTS	98	68.53
Dytiscidae - larvae	7	4.90
Tipula sp.	7	4.90
Optioservus sp.	6	4.20
TOTAL DOMINANTS	118	82.52

SAPROBIC INDICES

Hilsenhoff Biotic Index	6.50

DIVERSITY MEASURES

Shannon H (loge)	2.04
Shannon H (log2)	2.95
Evenness	0.64
Simpson D	0.14

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	39	27.27
Univoltine	87	60.49
Semivoltine	18	12.24

	#TAXA	ABUNDANCE	PERCENT
Tolerant	8	23	16.08
Intolerant	0	0	0.00
Clinger	6	28	19.58

Aquatic Invertebrate Taxonomic Data

Site Name: Spring Creek near mouth
Site ID: 5/30/01

Approx. percent of sample used: 3

Taxon	**Quantity**	**Percent**	**HBI**	**FFG**
Nematoda	1	0.33	5	PA
Tubificidae - immature	25	8.25	9	CG
Limnodrilus hoffmeisteri	21	6.93	9	CG
Lumbriculidae	1	0.33	8	CG
Physidae	1	0.33	8	CG
Gammarus sp.	58	19.14	6	CG
Acari	1	0.33	5	PA
Total Misc. Taxa	**108**	**35.64**		
Centroptilum sp.	1	0.33	2	CG
Diphetor hageni	1	0.33	5	CG
Caenis latipennis	61	20.13	7	CG
Total Ephemeroptera	**63**	**20.79**		
Sigara sp.	1	0.33	8	PH
Total Hemiptera	**1**	**0.33**		
Hydropsyche sp.	5	1.65	4	CF
Hydroptila sp.	16	5.28	6	PH
Lepidostoma sp.-turret case larvae	1	0.33	2	SH
Limnephilus sp.	1	0.33	3	SH
Total Trichoptera	**23**	**7.59**		
Dytiscidae - larvae	3	0.99	5	PR
Dubiraphia sp.	1	0.33	6	CG
Optioservus sp	35	11.55	4	SC
Total Coleoptera	**39**	**12.87**		
Ceratopogoninae	25	8.25	6	PR
Empididae - pupa	1	0.33	6	PR
Caloparyphus sp.	1	0.33	8	CG
Tipula sp.	1	0.33	4	OM
Total Diptera	**28**	**9.24**		
Corynoneura sp.	2	0.66	7	CG
Cricotopus sp.	9	2.97	7	CG
Cricotopus Bicinctus Gr.	9	2.97	7	CG
Eukiefferiella Pseudomontana Gr.	1	0.33	8	OM
Paratendipes sp.	3	0.99	8	CG
Potthastia sp.	2	0.66	2	CG
Thienemanniella sp.	2	0.66	6	CG
Thienemannimyia Gr.	13	4.29	6	PR
Total Chironomidae	**41**	**13.53**		
Grand Total	**303**	**100.00**		

Aquatic Invertebrate Summary Data

Site Name: Spring Creek near mouth **Site ID: 5/30/01**

TOTAL ABUNDANCE	303
Ephemeroptera + Plecoptera + Trichoptera (EPT) abundance	86
TOTAL NUMBER OF TAXA	30
Number EPT taxa	7

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Misc. Taxa	7	108	35.64
Odonata	0	0	0.00
Ephemeroptera	3	63	20.79
Plecoptera	0	0	0.00
Hemiptera	1	1	0.33
Megaloptera	0	0	0.00
Trichoptera	4	23	7.59
Lepidoptera	0	0	0.00
Coleoptera	3	39	12.87
Diptera	4	28	9.24
Chironomidae	8	41	13.53

RATIOS OF TAX GROUP ABUNDANCES

EPT/Chironomidae	2.10

FUNCTIONAL FEEDING GROUP (FFG) COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Predator	4	42	13.86
Parasite	2	2	0.66
Collector-gatherer	16	198	65.35
Collector-filterer	1	5	1.65
Macrophyte-herbivore	0	0	0.00
Piercer-herbivore	2	17	5.61
Scraper	1	35	11.55
Shredder	2	2	0.66
Xylophage	0	0	0.00
Omnivore	2	2	0.66
Unknown	0	0	0.00

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filterer	7.00
Scraper/(Scraper + C.filterer)	0.88
Shredder/Total organisms	0.00

CONTRIBUTION OF DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Caenis latipennis	61	20.13
Gammarus sp.	58	19.14
Optioservus sp.	35	11.55
Tubificidae - immature	25	8.25
Ceratopogoninae	25	8.25
SUBTOTAL 5 DOMINANTS	204	67.33
Limnodrilus hoffmeisteri	21	6.93
Hydroptila sp.	16	5.28
Thienemannimyia Gr.	13	4.29
Cricotopus sp.	9	2.97
Cricotopus Bicinctus Gr.	9	2.97
TOTAL DOMINANTS	272	89.77

SAPROBIC INDICES

Hilsenhoff Biotic Index	6.42

DIVERSITY MEASURES

Shannon H (loge)	2.15
Shannon H (log2)	3.10
Evenness	0.63
Simpson D	0.10

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	48	15.68
Univoltine	217	71.45
Semivoltine	39	12.87

	#TAXA	ABUNDANCE	PERCENT
Tolerant	12	182	60.07
Intolerant	0	0	0.00
Clinger	6	75	24.75

Aquatic Invertebrate Taxonomic Data

Site Name: Blackleaf Creek, lower FS boundary
Site ID: 5/31/01

Approx. percent of sample used: 100

Taxon	Quantity	Percent	HBI	FFG
Enchytraeidae	6	2.55	4	CG
Total Misc. Taxa	**6**	**2.55**		
Cinygmula sp.	1	0.43	4	SC
Total Ephemeroptera	**1**	**0.43**		
Podmosta sp.	71	30.21	2	SH
Total Plecoptera	**71**	**30.21**		
Rhyacophila Alberta Gr.	1	0.43	0	PR
Total Trichoptera	**1**	**0.43**		
Agabus sp.	1	0.43	5	PR
Total Coleoptera	**1**	**0.43**		
Dolichopodidae	1	0.43	4	PR
Prosimulium sp.	142	60.43	3	CF
Dicranota sp.	2	0.85	3	PR
Total Diptera	**145**	**61.70**		
Eukiefferiella Gracei Gr.	1	0.43	4	OM
Micropsectra sp.	3	1.28	7	CG
Orthocladius sp.	4	1.70	6	CG
Pagastia sp.	1	0.43	1	CG
Rheotanytarsus sp.	1	0.43	6	CF
Total Chironomidae	**10**	**4.26**		
Grand Total	**235**	**100.00**		

Aquatic Invertebrate Summary Data

Site Name: Blackleaf Creek, lower FS boundary **Site ID: 5/31/01**

TOTAL ABUNDANCE	235
Ephemeroptera + Plecoptera + Trichoptera (EPT) abundance	73
TOTAL NUMBER OF TAXA	13
Number EPT taxa	3

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Misc. Taxa	1	6	2.55
Odonata	0	0	0.00
Ephemeroptera	1	1	0.43
Plecoptera	1	71	30.21
Hemiptera	0	0	0.00
Megaloptera	0	0	0.00
Trichoptera	1	1	0.43
Lepidoptera	0	0	0.00
Coleoptera	1	1	0.43
Diptera	3	145	61.70
Chironomidae	5	10	4.26

RATIOS OF TAX GROUP ABUNDANCES

EPT/Chironomidae	7.30

FUNCTIONAL FEEDING GROUP (FFG) COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Predator	4	5	2.13
Parasite	0	0	0.00
Collector-gatherer	4	14	5.96
Collector-filterer	2	143	60.85
Macrophyte-herbivore	0	0	0.00
Piercer-herbivore	0	0	0.00
Scraper	1	1	0.43
Shredder	1	71	30.21
Xylophage	0	0	0.00
Omnivore	1	1	0.43
Unknown	0	0	0.00

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filterer	0.01
Scraper/(Scraper + C.filterer)	0.01
Shredder/Total organisms	0.13

CONTRIBUTION OF DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Prosimulium sp.	142	60.43
Podmosta sp.	71	30.21
Enchytraeidae	6	2.55
Orthocladius sp.	4	1.70
Micropsectra sp.	3	1.28
TOTAL 5 DOMINANTS	226	96.17

SAPROBIC INDICES

Hilsenhoff Biotic Index	2.84

DIVERSITY MEASURES

Shannon H (loge)	0.73
Shannon H (log2)	1.05
Evenness	0.28
Simpson D	0.35

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	8	3.19
Univoltine	226	96.17
Semivoltine	2	0.64

	#TAXA	ABUNDANCE	PERCENT
Tolerant	2	2	0.85
Intolerant	1	1	0.43
Clinger	4	145	61.70